ity spectrometers with a straight drift region are about one meter long. For the construction of small, medium- to high-resolution mobility analyzers, a solution is required which reduces the overall length without diminishing the mobility resolution.

[0019] In the publication WO 2004/109741 A2 (John Noyes, priority date Jun. 6, 2003) methods and arrangements have been proposed where ions can be introduced into a laminar gas flow, kept inside the laminar gas flow by an ion guide, and pushed over the maximum of an opposing electric field of a potential barrier. Ions which are pushed over are separated from ions which are held back by the electric field opposing the gas flow. By changing the barrier, the boundary between the ions pushed over and those held back can be varied. The publication does not give a definition of the term "laminar"; however, the disclosed system is designed to produce a laminar gas flow in a tube. The tube is located inside an RF quadrupole rod ion guide and is manufactured from a high-resistance conducting dielectric material so that the RF field can penetrate the tube wall and keep the ions in the axis of the laminar gas flow. This tube and the ion guide are the essence of the invention disclosed in the publication which is completely oriented toward the gas flow in this tube with corresponding parabolic velocity profile; see here FIGS. **8** and **9** and the accompanying descriptions, for example.

[0020] Although no methods for acquiring mobility spectra are presented in this publication, it is nowadays obvious that mobility spectra can be acquired with this arrangement. However, since the publication gives no measured values at all regarding the separation of ions at the barrier, it is not possible to infer from this publication whether, and how well, the separation of ions of different mobility would work and whether a sufficiently good mobility resolution could be achieved. A fundamental disadvantage of the method presented in this publication is that a parabolic velocity profile prevails in a laminar gas flow through a tube, so only the ions on the axis experience the maximum friction, with which they can be pushed over the barrier. The RF multipole rod system must therefore produce very good focusing of the ions on the axis of the tube in order to offset this disadvantage.

[0021] In general, electric field barriers are connected with electric potential distributions, usually with potential barriers. The maximum of the electric field component of a potential barrier in opposite direction to the flowing gas will be simply called "field maximum" or "field barrier" below. The field maximum is identical to the steepest part of the positive slope of the potential distribution of the potential barrier in the direction of the gas flow.

[0022] A publication by J. S. Page et al., "Variable low-mass filtering using an electrodynamic ion funnel", Journal of Mass Spectrometry. 2005, 40: 1215-1222 elucidated the use of an ion funnel to suppress ions of low mass in the range up to about 500 daltons, which often form a strongly interfering background in mass spectra. The authors hold back light ions below an adjustable mass threshold at the end of the ion funnel by means of an adjustable potential barrier at a ring diaphragm and filter them out of the ion current. To explain this effect, the authors propose that essentially the gas flow in the ion funnel pushes the ions over the field barrier connected with the potential barrier as a function of their mobility, and that the mobility of the light ions here gives the impression of a mass dependence because, for light ions, the mobility is mainly inversely proportional to the mass of the ions. The authors have made no attempt to use this effect to measure the ion mobility, however, despite extensive measurements on the suppression of light ions.

SUMMARY

[0023] In accordance with the principles of the invention, a jet of ion-containing gas is produced by free expansion of the gas through a nozzle into a vacuum and used to push ions of sufficiently low ion mobility over an electrical field barrier, thus sorting the ions according to their mobilities. No ion guide is necessary if the field barrier is located adjacent to the exit of the nozzle. If the field barrier is located in some distance from the nozzle, an ion guide may serve to canalize the ions to the field barrier. The ion guide should be shaped so as to minimize any hindrance to the free expansion of the gas outside the jet. These ion guides can take the form of ion funnels, but also of multipole rod systems. The ion guides serve to hold the ions together in the radial direction; propulsion in the axial direction is not important as long as the ions are kept entrained by the gas jet. For ion funnels, propulsion in axial direction is required, because ions can leave the gas jet inside the wide part of the ion funnel and have to be redirected into the gas jet.

[0024] In another embodiment, a jet of ion containing gas is formed by adiabatic expansion of the gas through a Laval nozzle. The jet is used in conjunction with an electric field barrier to sort the ions into those which are pushed by the jet over the field barrier, and those which are held back by the field barrier. To make the gas expand through the nozzle, a pressure difference at both sides of the nozzle has to be maintained, for example by a differential pumping system.

[0025] In still another embodiment the current of ions which are pushed over the field barrier by the gas jet, is measured with constant replenishment of ions from the ion source, as a function of the height of the voltage at the electrodes which generate the barrier. If the height of the field barrier is changed continuously or incrementally, a total ion current curve, which represents an integral over the mobility spectrum, is measured at the ion detector. Differentiation of this total ion current curve with respect to the height of the potential barrier provides the mobility spectrum of the ions. This method of acquiring mobility spectra can be calibrated by using ions of exactly known mobility; absolute values of ion mobilities can then be determined by calibrated spectrum acquisition methods.

[0026] If the ion current is fed to a mass analyzer and measured in the form of a series of mass spectra as a function of the height of the potential barrier, for example using a time-of-flight mass spectrometer with orthogonal ion injection, individual ion current curves for ions of individual mass ranges can be derived from this series of mass spectra, The differentiation of these curves then provides ion mobility spectra for individual mass ranges. The mass ranges can cover ions of several masses, such as the masses of an isotopic group, or only ions of a single mass.

[0027] In yet another embodiment, the ion guide is used as an ion storage device from which, after the filling is complete, the ions are blown over a continuously or incrementally diminishing field barrier and on to the ion detector by the gas jet. This allows a mobility spectrum from low to high mobilities to be measured directly, i.e. without differentiation.

[0028] This method can also be used to measure ion mobility spectra for individual mass ranges if a mass spectrometer is connected as the mass analyzer. Since, in this case, the ions